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INTRODUCTION

Thousands of acres of second-growth yellow-poplar are reaching merchantable size every year in the Southern Appalachians. Since the market for roundwood is limited and this large area is in need of thinning, lumber is the logical outlet. But the timber is young, the logs are relatively small, and they contain too low a proportion of heartwood to qualify for FAS grade lumber. Consequently, second-growth poplar still has a stigma of undesirable quality attached to it by local sawmillers and lumber buyers. Furthermore, rangers and other timber appraisers haven't had a real knowledge of what such timber is worth until now, and for that reason haven't been marking such trees for sale. In view of these facts, it became apparent early in 1955 that grade yield information for second-growth yellow-poplar logs and trees was much needed.

As a first step, a preliminary grade yield investigation was made in cooperation with the Bemis Lumber Company at Robbinsville, North Carolina (Study 1). The 69 trees cut for this analysis came from a good yellow-poplar site and yielded a large proportion of No. 1 Common and Better lumber. Consequently, a check examination was made in cooperation with the Carr Lumber Company at Brevard, North Carolina (Study 2). This time an area with a site index averaging 85 feet was examined and 58 trees were cut. The much lower grade yields for the same grades of logs in this study indicated that there might be differences between graders or among sites. A third test was made at the Carr mill (Study 3), using the same lumber grader and sampling 60 yellow-poplars from a site averaging 115 feet. The fourth study was made at the Bemis mill (Study 4) with the same lumber grader used in the first investigation and sampling 49 yellow-poplars from sites ranging from 80 to 120 feet.

STUDY METHODS

The trees for all four studies were cut from national forest lands typical of the Southern Appalachian region. The stands averaged 52 years old, with a range in age for individual trees of 44 to 63 years. Elevations included were from 2,100 feet above sea level to 3,600 feet, approximately the entire altitudinal range in which commercial stands are commonly found (fig. 1).

Figure 1.--Above, portion of the stand used in Study 2. Elevation 3,600 feet, average site index 85 feet, average age 52 years. Below, portion of the stand used in Study 3. Elevation 2,700 feet, average site index 115 feet, average age 53 years.

The first grading[1] was an estimate of tree grade made in standing timber, necessarily ignoring end defects. Diameter at breast height was measured, the number of 16-foot logs estimated, and the butt logs were carefully graded (fig. 2). After the trees had been felled and bucked, each log was scaled and the defects were diagrammed by type and location. Each log was then graded on the basis of Forest Products Laboratory hardwood log grades.[2] The bucking was done carefully but not specifically for grade, and actual log lengths were used in scaling and grading. After the logs had been diagrammed and band sawed, the lumber was graded by a National Hardwood Lumber Association inspector and tallied according to dimension and grade. The distribution of logs and trees by grade was as follows:

Logs		Trees	
(Grade)	(Number)	(Grade)	(Number)
1	90	A	77
2	179	B	75
3	223	C	57
4	254	D	27
Total	746		236

Lumber yields by tree size and grade were compiled. We computed quality index values (Q.I.) for each log and each tree, using basic index values reported by Ellertson and Lane,[3] so that the relationships between log size (d.i.b.) and grades could be established with regression techniques.

Synthesized Q.I. values were determined for trees of varying grades and diameters up to 26 inches d.b.h. These values were based on the actual grade of the butt log including end defects, and the assumption that the second and each succeeding log is one grade lower than the preceding log. The tree Q.I. weighted by proportionate volumes was then plotted, curves were constructed, and values tabulated.

RESULTS

Logs and Trees Can Be Tree Graded

Approximately two-thirds of all logs cut were of factory grade, and the remaining third were below factory grade (called 4's). The factory grade logs were all diagrammed and graded. Eighty-five percent of these logs were the same grade after diagramming as when graded in the tree. Furthermore, 82 percent of the trees had been correctly tree graded.[4] Small knots, the most important cause of misgrading standing trees, accounted for 44 percent of the missed cases (table 1).

1/ Campbell, R. A. Tree grades, yields and values for some Appalachian hardwoods. Southeast. Forest Expt. Sta. Paper 9, 26 pp. 1951.

2/ U.S. Forest Products Laboratory. Hardwood log grades for standard lumber. Rpt. D1737. 1949.

3/ B. Ellertson and P. Lane. Lumber price ratios. U. S. Tenn. Val. Authority Div. Forest Relat. Tech. Note 15. 1953.

4/ "Tree grading" is defined as application of Forest Products Laboratory hardwood log grades to the butt 16-foot log in the standing trees, with each succeeding 16-foot log assumed to be a grade lower. A description can be found in the reference cited in footnote 1 in this paper.

Figure 2.--Above, loading logs, Study 3. Factory grade 1 log being loaded, factory grade 3 log in foreground already on truck. Below, railroad carload of logs from Study 1 (good site) near Robbinsville, N. C.

Table 1. --Number and cause of differences between estimated and actual tree grade

Study	Changes				Reasons for change			
	None	Up	Down	Total	Knots	Log taper	Other 1/	Total
	Number							
Study 1	49	16	4	69	11	8	1	20
Study 2	47	1	1	49	--	1	1	2
Study 3	45	12	1	58	6	2	5	13
Study 4	52	5	3	60	2	--	6	8
All	193	34	9	236	19	11	13	43
Percent	82	14	4	100	44	26	30	100

1/ Other includes 2 log scars, 2 birdpeck, 1 rot, 2 ridges, and 6 unknown.

It was found that exterior indications of adventitious buds, bird pecks, and grubs are not defects in second-growth yellow-poplar logs and trees (fig. 3), since graded lumber cut from faces with these surface aberrations showed no degrade.

Second-Growth Yellow-Poplar Has Quality Yield

Quality index values for both logs and trees have been computed on the basis of lumber yields and values (table 2). The variation within and between grade averages can best be compared by reference to the quality index values.

Table 2. --Comparative grade yields of second-growth yellow-poplar lumber by log grade 1/

Log grade	Study	Q. I.	Lumber grade						
			FAS	Sel.	Sap	1C	2A	2B	3C
			Percent						
1	Study 1	113	4	26	18	35	13	3	1
	Study 2	93	--	--	28	27	35	9	1
	Study 3	106	1	10	34	24	29	1	1
	Study 4	93	1	13	1	52	28	4	1
	Average	101	1	13	20	35	26	4	1
2	Study 1	96	2	11	7	43	22	11	4
	Study 2	80	--	--	8	25	41	24	2
	Study 3	86	--	2	12	33	45	7	1
	Study 4	81	--	3	--	46	41	9	1
	Average	85	--	4	7	37	37	13	2
3	Study 1	76	--	2	1	40	27	25	5
	Study 2	61	--	--	--	9	41	46	4
	Study 3	69	--	--	2	18	50	29	1
	Study 4	68	--	--	--	21	57	21	2
	Average	68	--	--	1	22	44	30	3
4	Study 1	59	--	--	--	13	30	44	13
	Study 2	54	--	--	--	1	27	65	7
	Study 3	57	--	--	--	5	29	58	8
	Study 4	62	--	--	--	7	54	32	7
	Average	58	--	--	--	7	35	50	8

1/ Based on a total of 746 logs (86,740 bd. ft. lumber).

Figure 3. --Above, occluded grub hole (bark scar) of no importance, Study 1, near Robbinsville, N. C. Below, deck of assorted logs from good site, Study 3, Brevard, N. C. Bird peck on logs in foreground did not lower the grade.

When average grade yields and corresponding Q.I. values were used as a base (table 2), this variation in value was found to be greatest in the top grade (No. 1 logs), amounting to as much as 20 Q.I. points (93 to 113). This difference expressed in dollars per M b.f., with No. 1 common lumber values at $100 per M b.f., would amount to $20. In grade 2 logs the difference from the mean quality index of 85 is a plus $11 per M b.f. to a minus $5, and in grade 3 it ranges from plus $8 to a minus $7 from the mean Q.I. of 68. In grade 4 it is only ± $4 from a mean quality index of 58.

The relationship of estimated tree Q.I. to d.b.h. by grade is illustrated in figure 4. Statistical analyses of log values show that the estimated Q.I. values differed from the actual Q.I. values in only 3 out of the 12 tests made (3 studies and 4 log grades). Furthermore, in only one case, grade B logs of Study 1, did the difference amount to more than ± 4 percent. In this case the variation amounted to ± 8 percent. Statistically, the estimated Q.I. values for trees did not differ significantly from the actual Q.I. values.

Site Affects Quality Index of the Better-Grade Logs and Trees

In each study, logs of each grade obtained from trees of known site index were analyzed separately. Grade 1 logs showed a difference by site of over 20 Q.I. points within the sampled range (site indexes 70 to 130). Grade 2 logs showed 7 Q.I. points difference between the same size logs from good and poor sites. Grade 3 logs had 11 Q.I. points difference between logs of the same size from good versus poor sites. The relative values of grade 4 logs were low, and apparent differences were insignificant.

Grade 1, 2, and 4 logs did not differ in Q.I. points between mills. Only in the case of grade 3 logs did the mill prove significant.

The effect of site on logs and tree values, measured in quality index points, is shown in tables 3 and 4. As might be expected, grade A trees show the greatest variation in terms of Q.I. units for any given d.b.h.

Table 3. --Quality index values by site and size for log grades 1 and 2

Diameter inside bark (inches)	Log grade 1, with site index of--			Log grade 2, with site index of--		
	120	100	80	120	100	80
	Quality Index values					
12	108	100	92	84	81	78
14	108	100	92	86	83	79
16	108	100	92	88	85	81
18	108	100	92	90	86	83
20	108	100	92	92	88	85
22	108	100	92	94	90	87
24	108	100	92	95	92	88

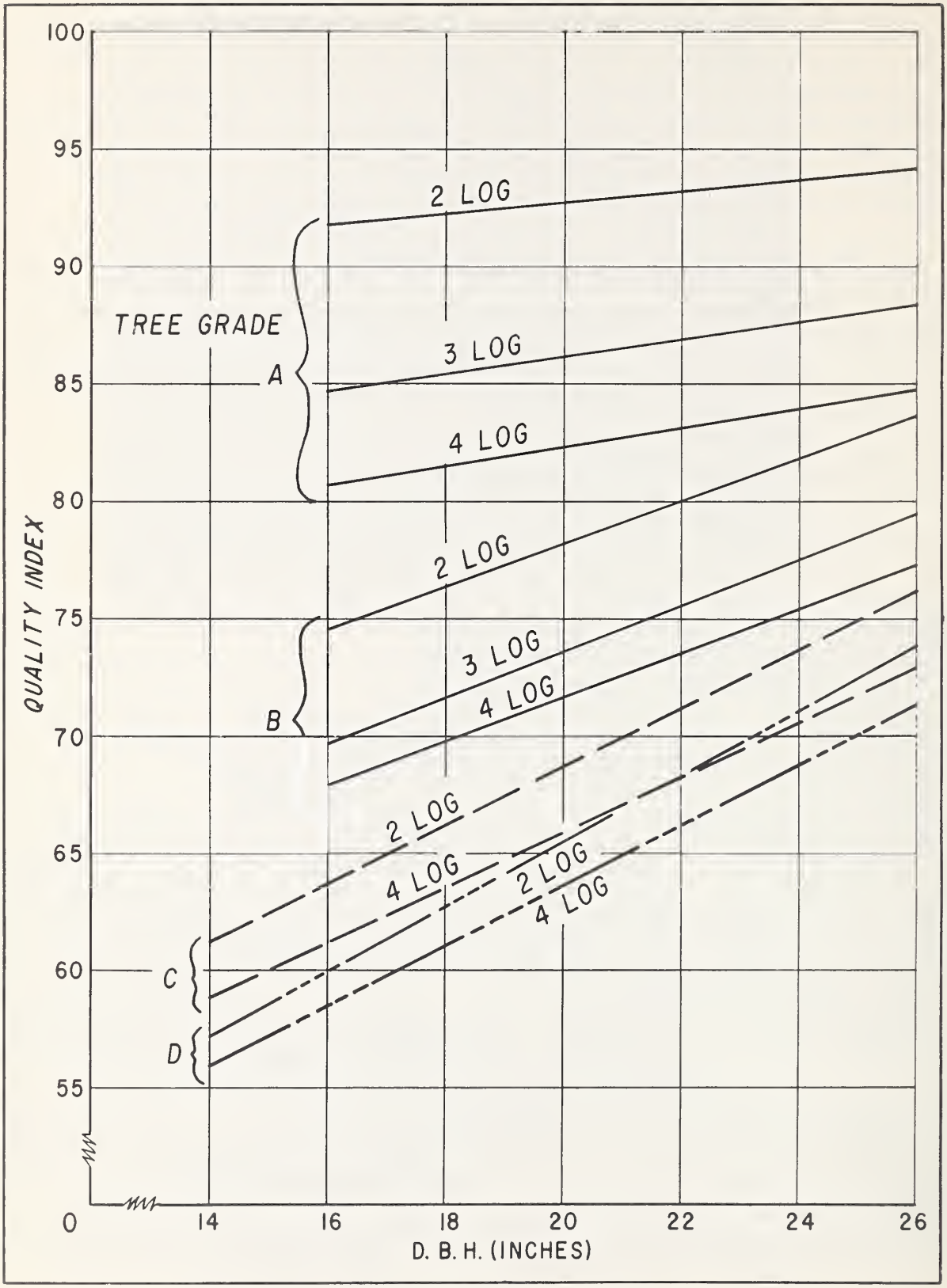

Figure 4.--Quality index values by grade and size.

Table 4. --Quality index values by site and size for tree grades A and B

Merchantable logs (number)	D. b. h.	Tree grade A, with site index of--			Tree grade B, with site index of--		
		120	100	80	120	100	80
	Inches	Quality Index values					
2 logs	16	98	92	86	76	75	72
	18	98	92	86	78	76	74
	20	99	93	87	80	78	76
	22	99	93	87	82	80	78
	24	100	94	87	84	82	80
	26	100	94	88	86	84	82
4 logs	16	84	81	77	69	68	66
	18	85	81	78	71	70	68
	20	86	82	78	73	72	70
	22	87	83	79	75	74	72
	24	87	84	80	76	75	74
	26	88	85	81	78	77	76

When site differences are expressed in dollars per M b.f. for the stumpage (conversion values) as shown in table 5, they are impressive; e.g., 20-inch grade A 2-log trees from site index 120, an excellent site, are worth $52.50 per M, while those from site index 80, a fair site, are worth $40 per M. Stumpage values for grades C and D are shown in table 6.

Table 5. --Stumpage values [1/] per M b.f. by site and size for tree grades A and B
(Dollars per M b.f.)

D. b. h. (inches)	2-log trees		4-log trees	
	Grade A	Grade B	Grade A	Grade B
	SITE INDEX 120, (EXCELLENT)			
16	43.00	21.50	30.00	15.00
18	49.00	28.50	35.00	21.00
20	52.50	33.50	40.00	26.50
22	54.00	38.00	42.50	30.50
24	56.50	41.00	44.00	33.50
26	56.00	42.00	44.00	34.50
	SITE INDEX 100, (GOOD)			
16	37.50	20.00	26.50	13.50
18	42.50	27.00	31.50	19.50
20	46.00	31.50	36.00	25.00
22	49.00	36.00	39.00	29.00
24	50.50	39.00	41.00	32.00
26	50.00	40.50	41.00	33.00
	SITE INDEX 80, (FAIR)			
16	31.50	17.50	22.50	12.00
18	36.50	24.50	27.50	18.00
20	40.00	29.50	32.00	23.50
22	43.00	34.00	35.00	27.50
24	44.50	37.00	37.00	30.50
26	44.00	38.00	37.00	32.00

1/ Values based on No. 1 common lumber at $115 per M b.f., less 12 percent for profit and risk, less logging and milling costs as shown by diagram in figures 5 and 6.

Table 6. --Stumpage values [1] per M b.f. by size for tree grades C and D

D.b.h. (inches)	2-log trees		4-log trees	
	Grade C	Grade D	Grade C	Grade D
	Dollars			
14	2.00	(2/)	(2/)	(2/)
16	10.00	6.00	7.50	4.50
18	17.00	13.00	14.00	11.50
20	23.00	19.00	19.00	17.00
22	28.00	24.00	25.00	22.00
24	31.00	27.50	27.50	25.50
26	32.00	28.00	28.00	26.00

1/ Values based on No. 1 common lumber at $115 per M b.f., less 12 percent for profit and risk, less logging and milling costs, as shown in figures 5 and 6.

2/ Negative values.

Earnings and Stumpage Values

In computing stumpage values, it is necessary to reduce wholesale lumber prices by a profit and risk margin and then deduct the average logging and milling costs, as shown in figures 5 and 6. The wholesale lumber prices for No. 1 common yellow-poplar were averaged at $115 per thousand board feet. This value was reduced by 12 percent for profit and risk. Tree Q.I. values by grade and size, shown in figure 4, were multiplied by the net lumber price of $101, and the results together with logging and milling costs are illustrated in figures 5 and 6. The difference between the costs and the net lumber price indicate stumpage values (equivalent to conversion values) per thousand board feet (tables 5 and 6).

As shown in table 5, stumpage values per M increase by tree size in fairly constant amounts. When 4-log trees increase in diameter from 16 to 26 inches d.b.h., the dollar value per M b.f. on 100-foot sites increases as follows: grade A trees increase 1.5 times in value, B's double, C's quadruple, and D's increase sixfold in value. Stumpage values as shown in tables 7 and 8 increase even faster over the same conditions: grade A's fivefold, B's eightfold, C's thirteen, and D's sixteenfold. Furthermore, a tree of a given log length will increase in value rapidly if it improves in grade as it grows in diameter. For example, a grade D tree now measuring 16 inches d.b.h. can improve to grade C with only 2 inches of diameter growth and will increase in value 50 to 100 percent (depending on the number of logs in the tree chosen for comparison). A grade C tree improving to a grade B with the same 2-inch-diameter growth will increase fourfold in dollar value. A corresponding increase in value will result if a tree remains in the same grade as it grows larger in diameter and taller in merchantable length. An even larger increase is possible if a tree increases in both grade and merchantable length while growing into a larger diameter class. If grade and length remain the same and the tree grows only in diameter, the owner will still earn 4 percent or more up to 26 inches d.b.h.

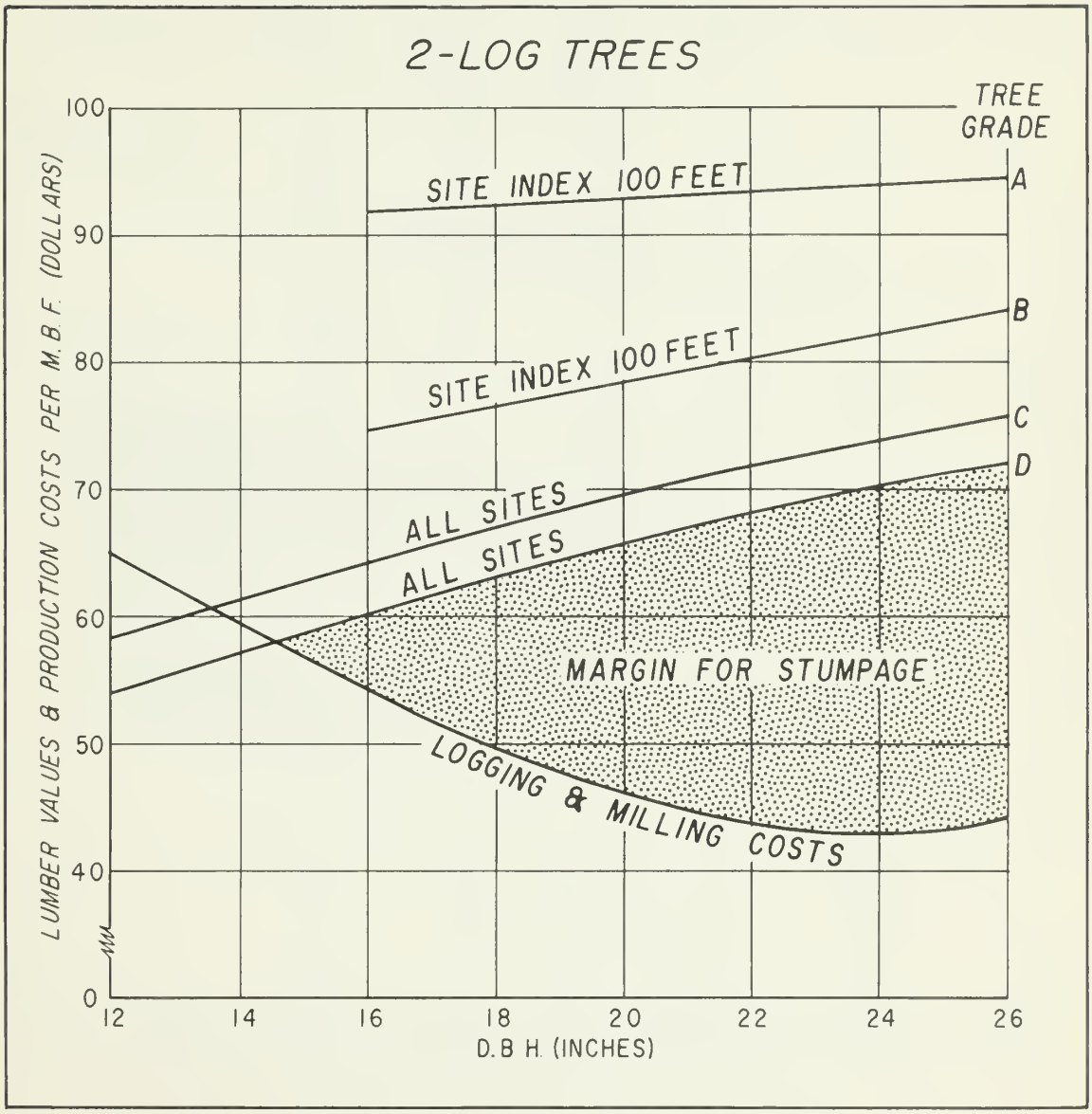

Figure 5. --Lumber values, logging costs, and stumpage margin per thousand board feet for 2-log trees. Based on quality index values for trees of different grades.

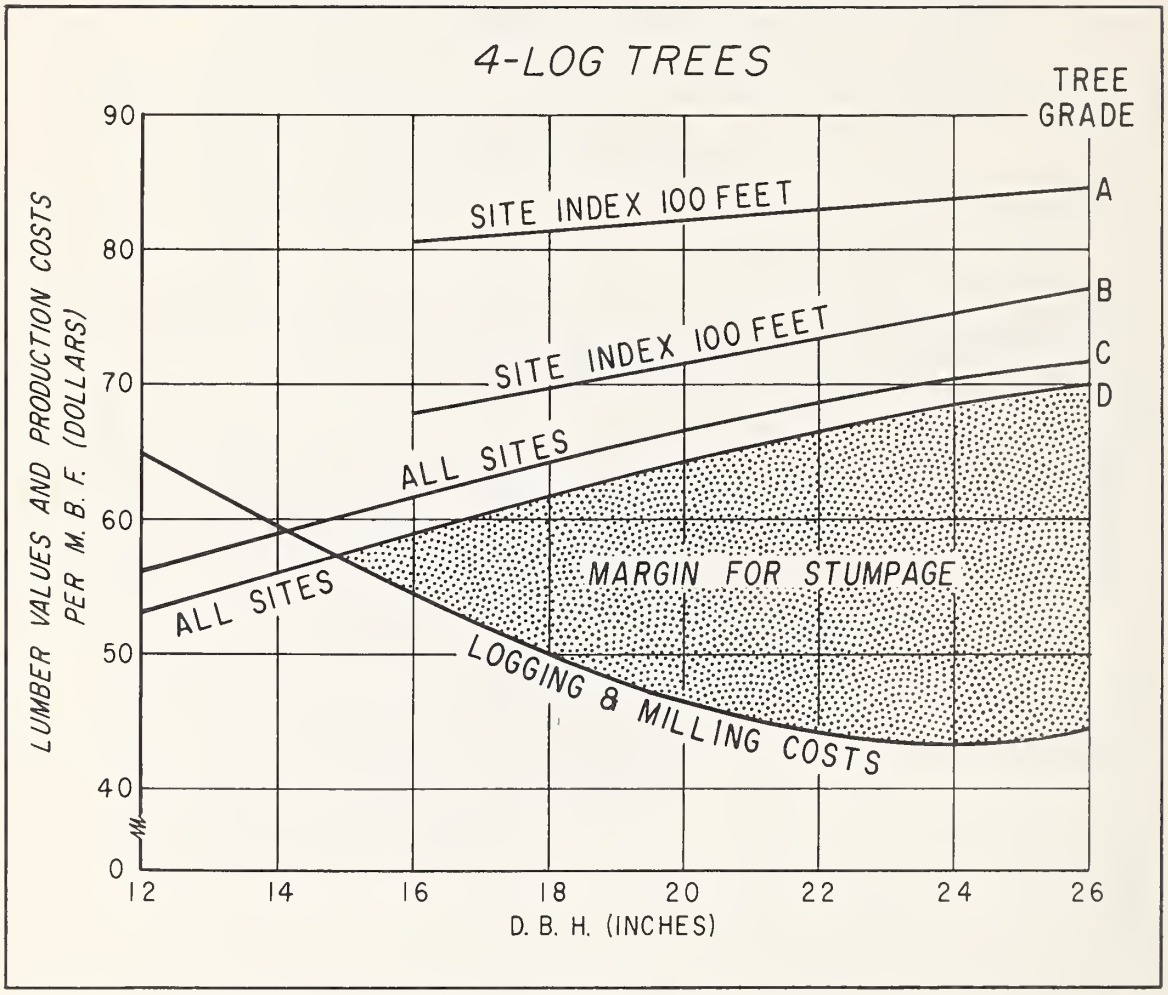

Figure 6. --Lumber values, logging costs, and stumpage margin per thousand board feet for 4-log trees. Based on quality index values for trees of different grades.

Table 7. --Curved stumpage values [1/] by site and size for tree grades A and B
(Dollars per tree)

Tree d.b.h. (and volume)	Site Index 120 (excellent)		Site Index 100 (good)		Site Index 80 (fair)	
	Tree grade A	Tree grade B	Tree grade A	Tree grade B	Tree grade A	Tree grade B
2-LOG TREES						
16 in. (185 bd. ft.)	8.00	4.00	7.00	3.50	5.75	3.25
18 in. (245 bd. ft.)	12.00	7.50	10.50	6.50	9.00	6.00
20 in. (315 bd. ft.)	16.50	10.50	15.00	10.00	13.00	9.50
22 in. (390 bd. ft.)	21.00	14.75	19.00	14.00	16.50	13.00
24 in. (470 bd. ft.)	26.00	19.00	23.50	18.50	21.00	17.00
26 in. (555 bd. ft.)	31.00	24.00	28.50	23.00	25.00	22.00
4-LOG TREES						
16 in. (290 bd. ft.)	8.50	4.00	7.50	3.75	6.25	3.50
18 in. (390 bd. ft.)	14.00	8.50	12.50	7.75	11.00	7.00
20 in. (510 bd. ft.)	20.50	13.50	18.50	12.50	16.00	12.00
22 in. (640 bd. ft.)	27.00	19.50	25.00	18.50	22.00	17.00
24 in. (780 bd. ft.)	34.00	25.50	32.00	24.50	28.50	23.00
26 in. (920 bd. ft.)	40.50	32.00	39.00	31.00	35.00	30.00

1/ Tree values are based on stumpage values shown in table 5. Computed values were plotted and curves were drawn from which the above values were read.

Table 8. --Stumpage values [1/] by size for tree grades C and D

Tree d.b.h. (and volume 2/)	Average site index, 2-log trees		Tree d.b.h. (and volume 2/)	Average site index, 4-log trees	
	Tree grade C	Tree grade D		Tree grade C	Tree grade D
12 in. (105 bd. ft.)	(3/)	(3/)	12 in. (150 bd. ft.)	(3/)	(3/)
14 in. (135 bd. ft.)	0.35	0.20	14 in. (210 bd. ft.)	0.30	(3/)
16 in. (185 bd. ft.)	1.80	1.20	16 in. (290 bd. ft.)	2.10	1.50
18 in. (245 bd. ft.)	4.40	3.30	18 in. (390 bd. ft.)	5.70	4.60
20 in. (315 bd. ft.)	7.20	5.80	20 in. (510 bd. ft.)	10.00	8.40
22 in. (390 bd. ft.)	10.50	8.80	22 in. (640 bd. ft.)	15.00	13.00
24 in. (470 bd. ft.)	14.00	12.00	24 in. (780 bd. ft.)	20.50	18.50
26 in. (555 bd. ft.)	18.00	16.00	26 in. (920 bd. ft.)	26.50	24.50

1/ Tree values are based on stumpage values shown in table 5. Computed values were plotted and curves were drawn from which the above values were read.

2/ Curved volumes from table 12, Jesse H. Buell, "Outside-bark form class volume tables for some Southern Appalachian species," U. S. Forest Serv. Appalachian Forest Expt. Sta. Tech. Note 53, 1942.

3/ Negative values.

SUMMARY

This report summarizes the results of four separate studies of log and tree grade yields for second-growth yellow-poplar conducted in western North Carolina during 1955, 1956, and 1957. The study included 236 trees and 746 logs cut from a wide range of sites.

Log and tree quality indices were computed and are shown by size and grade. Lumber and stumpage values are also given. Stumpage values for second-growth yellow-poplar trees of all grades increase rapidly with increasing diameter up to about 24 inches diameter at breast height.

The study shows that the tree grading method gives a workable estimate of lumber values from second-growth yellow-poplars and can be used with confidence by timber cruisers and appraisers. Accuracy is improved by recognition of site differences, particularly in the case of grade A and B trees.

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